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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Low Viscosity Lubrication

The Relation to Economy in Power Consumption

PUBLISHED MONTHLY BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

The VISCOSITY ELEMENT

EVOLUTION of the practice of lubrication to the status of a science has developed many theories. Some have been decidedly practicable and distinctly advantageous to those who have to do with the actual operation and maintenance of machinery.

On the other hand, some have been fantastic in their idealism, for it is impossible to eliminate friction entirely. Were this possible, perpetual motion could be more nearly attained.

Where study has been directed in an organized manner, however, with due consideration of not only the prevailing operating conditions but also the most practicable means of applying the lubricants, it has been possible to develop the salient characteristics of these latter to almost an ideal degree.

Viscosity, or relative fluidity, has received marked attention in this regard, for viscosity may involve the ultimate amount of internal friction developed. Obviously, if this latter can be reduced with safety, power consumption can likewise be decreased.

The results of this study have been outstanding in connection with the steam turbine, the textile spindle, the electric railway journal and in the formation of ceramic materials. So interesting have been the deductions that it is felt advisable to present a detailed discussion in this issue of "LUBRICATION" in the hope that further research will be encouraged.

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Low Viscosity Lubrication

The Relation to Economy in Power Consumption

POWER consumption in the operation of industrial machinery may amount to a material item in the total cost of plant operation. It is in fact, one of the most variable elements among the several which must be considered in developing production costs and the price to be charged for finished goods. In consequence, power consumption must be carefully studied, especially from the angle of factors such as lubrication and means of distribution, which may vitally affect the amount required to keep any particular piece of machinery up to operating requirements.

The condition of such machinery, however, will also react back upon the power consumption. As a result, in a study of this latter, it will not suffice to inventory the pounds of steam or number of kilowatts normally required. There will frequently be operating or constructional conditions which can be so changed as to reduce materially the power consumption.

In any one case this may be a comparatively small item. Over an entire plant, however, it may amount to an appreciable difference, viz.: in the case of textile spindle operation the consumption of one watt per spindle more or less may seem negligible, but in a mill operating upward of 100,000 spindles the potential power savings may frequently be the balance between success and failure in meeting competitive prices on finished goods.

Lubrication has proven to be a decided factor in this development of lower power consumption requirements in certain industries, especially where the matter of actual elimination of frictional excesses may be involved.

In this connection, research has indicated that there are certain machine operations wherein the use of a low viscosity lubricant will promote efficiency, and increase power economy. Studies which have been carried out in this regard over the past two or three years have indicated strongly that there is a great deal to be derived from the use of lower viscosity lubricants for certain types of operation, provided these products are properly refined or compounded, and judicious study has been given to the means for their application.

It should not be assumed that this will apply to every phase of machinery operation, for there are certain operating conditions which will require the characteristic of body or viscosity to a marked degree.

On the other hand, where operating temperatures are not abnormal and where the load carried per unit of bearing area is not extreme, provided there is adequate means for distribution or maintenance of a sufficient film of oil between the wearing elements, the use of lower viscosity products will frequently be a distinct advantage.

This idea has been found especially adaptable to high speed service. The spinning frame spindle is a notable example and a condition of operation which has been given very careful study.

It has been felt, therefore, that an insight into the conditions which may permit the use of lower viscosity lubricants will be of consider-

able interest and may be the forerunner of the development of further study and improvements of operating conditions which may lead to increased power economy.

Those phases of operation which have received the most attention to date include the electric railway car wheel journal, the textile spindle, the steam turbine bearing, the brick or tile working machine and the knitting machine.

A most important point to bear in mind in regard to choice of viscosity of a lubricant for any specific operating conditions is that by the adoption of lower viscosity products the rate of heat absorption will be markedly improved. This will hold true not only at the bearings themselves, wherein the volume of oil passing through may serve to absorb heat developed during operation or received from outside sources, but also in the sump tanks or reservoirs, for an oil which will more readily absorb heat will likewise more easily give up this heat. The problem of cooling a lower viscosity oil, therefore, will be more easily accomplished than with a higher viscosity product.

Electric Railway Service

An important factor in the development of viscosity requirements has been the extent to which low viscosity oils have been proven to be adaptable to electric railway car equipment. In fact, the idea that a viscosity of from 400 to 600 seconds Saybolt at 100 degrees Fahr., is necessary, dependent upon climatic temperatures, has been more or less disproved by reason of the improvements in operation which have been indicated by the use of an oil with as low a viscosity as 38 seconds Saybolt at 100 degrees Fahr.

In order for such an oil to function effectively, however, it is obvious that every effort must be exerted to prevent entry of foreign matter. As a result, it must be amply protected in service by means of a suitable oil seal. The development of such a seal has been part of this study of the application of low viscosity oils to electric railway car wheel journal lubrication.

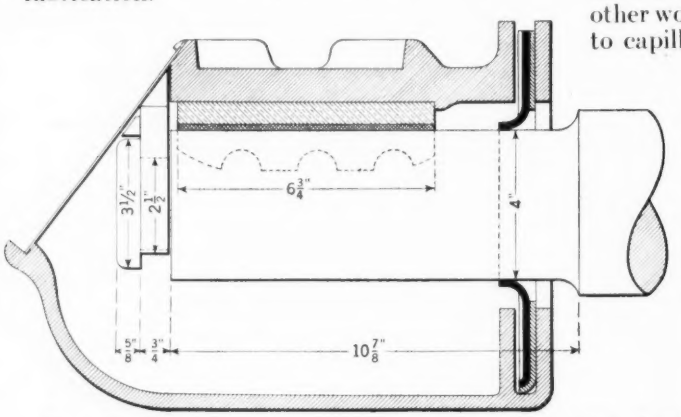


Fig. 1—Cross-section of an electric railway journal box. Note the leather oil seal, shown in heavy black at the rear of the box, and the relative location of the bearing above the journal. By use of this oil seal it is practicable to use an extremely low viscosity oil for lubrication.

The Duty Involved

In the operation of electric railway car equipment there is a decided possibility of lubricants becoming contaminated by dust, dirt, water, sand or metallic particles. Where there is no means provided to prevent entry of such non-lubricating matter it is evident that the lubricant itself must perform a dual function, for under such conditions the oil must not only reduce solid friction, but also by virtue of its viscosity it has to surround each particle of foreign matter in order to prevent contact between the latter and the surfaces of the bearing or the journal.

As a result, where there is no provision for the prevention of entry of such matter there must be sufficient viscosity to insure the above. Research has proven, however, that where non-lubricating abrasive matter can be prevented from gaining entry to such a lubricating system the sole function of the oil is that of actual lubrication and reduction of friction.

It is also important to remember, wherever there is a possibility of entry of foreign matter, that if the content of this nature is increased the fluidity of the oil will tend to decrease. In other words, there will be more resistance offered to capillary action as well as to flow of oil to the bearings via the waste. This would normally be expected to have an increasing effect upon the power consumption, especially when starting. Furthermore, it would be more apparent during cold weather operation, for even though the original oil might have a zero pour test the increase in viscosity might affect its flow to such an extent as to lead to impaired lubrication.

Low Viscosity Conducive to Year-Round Service

In this regard, it is interesting to note that in view of the fact that the low viscosity oil as developed for such service will always have a minus zero pour test, it will automatically become an all-year-round oil. In other words, the necessity for seasonal changing of oil which is so often objectionable, will be eliminated.

Effect on Partial Film Lubrication

Wherever comparatively heavy oils of high pour test are used on electric railway car equipment, there may be the possibility of impairment of the lubricating film, due to entry of waste strands into the bearing clearance and hindrance of oil circulation. This could be called development of partial film lubrication.

"Waste grabs" of this nature have normally been found to occur in cold weather where a comparatively highly contaminated oil was used, and where the waste itself had absorbed an extensive amount of dust, dirt and metallic particles. It is almost impossible to judge the extent to which waste may become contaminated in this manner, where there is no effective means provided for sealing the bearing ends.

When this occurs, simply renewing the waste will be inadequate, for wear of the journal and bearing surfaces will usually have taken place to such a marked degree as to necessitate installation of a new bearing, or even regrinding and finishing of the journal itself.

Where there is but inadequate provision for protection of the oil from contamination, however, actual operation has proven that all the above will be largely eliminated. Consequently, the possibility of overheating will be reduced, and the oil will feed more readily through the waste, to more nearly serve its intended purpose.

Tapered Journals Reduced

It has been proven, furthermore, that where a bearing is in good condition and is properly matched to the journal surface, if positive lubrication can be maintained the wear on both surfaces will be uniform. This has been very clearly observed wherever low viscosity oils in connection with a proper leather oil seal have been used. In fact, tapered journals have been rarely found.

Naturally this should be another distinct point in favor of such means of lubrication, for it indicated that the machine shop practice of regrinding and finishing tapered journals will be seldom necessary.

Courtesy of Saco-Lowell Shops.

Fig. 2—Showing the constructional details of a textile spindle. It is interesting to note that certain types of such devices can function on comparatively low viscosity oil. To insure dependable lubrication, however, all the cast iron parts are thoroughly washed in Benzine and dried before installing. These parts of Saco-Lowell spindles are then soaked for five hours in spindle oil, and assembled with as much oil as will adhere to them. The cross-section at the left shows a Saco-Lowell spindle with regular base and bolster and loose lock step. At the right is shown a spindle with regular base and suspended bolster.

Development of Running Fit

Another point which will be of particular interest to the master mechanic or machine shop foreman is that by use of scientifically prepared lubricants of a viscosity commensurate with the operating requirements, running fits will be obtained in a comparatively short space of time.

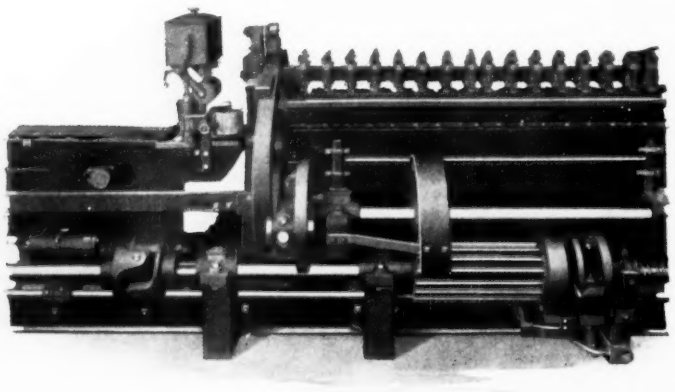
It is reasonable to expect that this is brought about by virtue of the fact that the nature of the oil enables the bearing metal to wear into accurate formation with the journal surface more readily than where there is possibility of entry of dust or dirt, or where the viscosity of the oil may be appreciably higher.

Indication of Trouble

In the electric railway industry, the usually accepted indication of bearing trouble has been the hot box. Where an oil of from 400 to 600 seconds Saybolt viscosity at 100 degrees Fahr., is used, considerable rise in temperature may normally occur before any appreciable amount of vaporization will be noticeable.

Frequently, in fact, by the time such vaporization does begin bearing temperatures will

be rising so rapidly as to cause the waste to actually burn as soon as the cover of the journal box is removed and an excess of air admitted. The only procedure after such an occurrence is to pull the car into the shop and subject the journal box, bearing and journal, to inspection and repair. Obviously, this will mean a car tie-up with accompanying expense for repair and time lost.



Courtesy of E. M. Freese and Company

Fig. 3—Showing a reciprocating automatic brick cutter. On any such machine it is important that the platen and clay column move together, in exact synchronization before the cutting wires begin to cut, regardless of the amount of oil on the platen or the consistency of the column. This insures the cutting of a straight brick. The oil reservoir is shown at the top left of the illustration.

Where oils of low viscosity are used, however, marked vaporization will develop at comparatively low temperatures. These latter will be sufficiently below the danger point to serve as an alarm signal before serious trouble can occur. Normally such a condition can be readily overcome by allowing the journal box to cool down and then pouring in a small quantity of oil to increase the degree of saturation of the waste.

Theory Involved

Inasmuch as effective lubrication has been the ultimate ideal in the development of the research work pertinent to use of low viscosity oils in electric railway service, a word in closing, to give a clearer understanding of the meaning of effective lubrication in such service, will be advisable.

Essentially it means the reduction of solid friction or metal-to-metal contact between the journal and bearing, in such a manner as to result in the minimum of wear or loss of power in the maintenance of motion or car operation.

This is brought about by the use of a lubricant which will be capable of maintaining a protective film between the wearing surfaces. This film must, of course, be of fluid nature in order that it may readily penetrate throughout all clearance spaces.

By means of this film, solid friction is supplanted by fluid friction. In other words, those microscopically high spots which exist on practically any metallic surface, regardless of its polish or machining, are prevented from coming in contact with each other.

If there is adequate fluidity within the lubricating film to facilitate ready conformation to the motion between the solid surfaces involved, a minimum of fluid friction should be developed. In other words, the film should most effectively serve its dual purpose in:

1. The elimination of metallic wear, and
2. The prevention of abnormal temperature rise.

The degree of success attained will depend upon the relative fluidity or viscosity of the oil which constitutes the lubricating film. A lubricant does not just lay in the clearance space and allow the moving part to slide over it, much as a sled runner would pass over smooth ice. Instead its component particles are in constant motion with respect to each other and to the metallic surfaces involved. If these particles move sluggishly, that is, if the viscosity is too high in accordance with the existing operating speed and pressure, they will tend to develop abnormal friction within the film itself. This will be indicated by rise in bearing temperatures and increase in power consumption, and the purpose of lubrication will be defeated.

Textile Machinery

For extremely high speed operation, as in the case of textile spindles, the use of low viscosity oils has been proven to be a decided advantage. This will hold true with the anti-friction bearing spindle as well as with the more familiar type of plain bearing design. These potential power economies in the operation of textile spindles are more marked than in any other phase of this industry, in view of the number of spindles employed and the extent to which actual power consumption can be reduced.

Extensive tests have proven that a power saving of from one to four watts per hour of

spindle operation can be attained, provided the condition of the spindle base is conducive to the use of a lower viscosity oil.

A further adjunct to the use of lower viscosity products has been indicated by the fact that staining from thrown or leaked oil can be reduced, as well as operating temperatures. In regard to this latter, it is well to remember that the suitability of a spindle oil can generally be noted by the temperature difference which exists between the spindles and the surrounding atmosphere. Under ideal conditions there should be no such difference. It is impossible, however, to eliminate friction absolutely, therefore, spindles will usually be found to operate somewhat warmer than room temperatures. A difference of approximately 10 degrees Fahr., may be regarded as a fair average, using an average spindle oil of from 70 to 100 seconds Saybolt viscosity.

Of course, the higher the viscosity of the oil the greater will be the internal friction, with the result that more power will be required to drive the spindles. For this reason every care should be taken to observe the above temperatures and reduce the viscosity of the oil as far as possible. On the other hand, this should not be carried to an extreme, otherwise there would be danger of metal-to-metal contact occurring. In this event, metallic friction would probably build up and excessive wear might occur. This would also be indicated by abnormal spindle temperatures, excessive power consumption, and perhaps ultimate seizing of the spindles. Long before this extreme, however, frequent breakage of the yarn would probably indicate that something was radically wrong.

It is essential, of course, to prevent spindle oil from coming in contact with the yarn as far as possible. Frequently, however, constructional details, carelessness or adverse operating conditions will render this ideal difficult to attain. As a result, it will be advisable at all times to use as light a colored mineral oil as is available and replenish oil in spindle bases when spindles are at rest.

When oil is placed in bases while spindles are up to speed a certain amount of pumping action is brought about, which throws oil from the base and is, to some extent, the cause of staining.

Elimination of Excessive Wear in Spindles

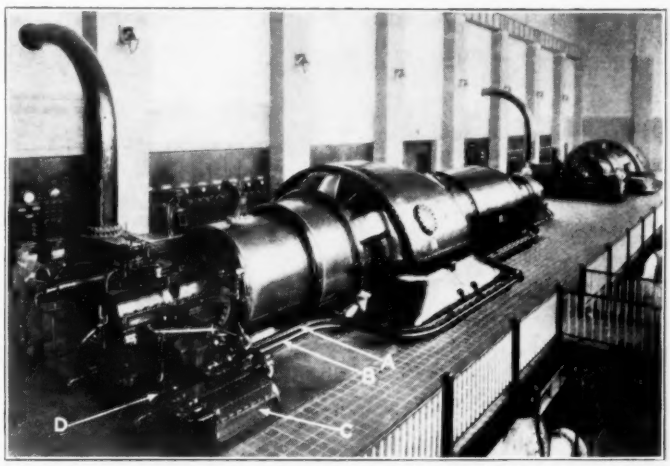
Where extremely low viscosity oils are used for spindle lubrication, when new spindle bases or bolsters are put in service and the oil applied, this latter may wash any cast iron boring dust present from the pores of the cast iron bolsters and boxes, permitting the retention of this dust at the bottom of the bolster. In the pivot type step bearing abrasive material of this nature may cause considerable wear. This same action occurs when heavier oils are applied, but the cutting action that takes place on the end of the spindle is not as noticeable.

Special care should, therefore, be exercised in placing new spindle equipment in service to see that all cast iron parts have been thoroughly washed in kerosine, or benzine followed by air blowing, both outside and inside, to clear away any boring dust.

Cleanliness Must Be Assured

Another important factor is cleanliness. Spindle oils are highly refined products, and every care should be taken in handling and storage to keep them free from contamination.

Such oils should be stored in clean containers, free from dust and dirt, and handled only in clean oil cans. It will also be advisable to clean out spindle oil reservoirs at frequent intervals and refill them with fresh oil, as stated in connection with the above mentioned tests. Regardless of the means taken to prevent it, a certain amount of foreign matter will gain entry, to cause wear, increased friction, discoloration of the oil, and perhaps very serious staining of the yarn.



Courtesy of Allis-Chalmers Mfg. Co.

Fig. 4—In steam turbine practice the provisions for protection of lubrication are decidedly extensive. In the above view, note size of the oil piping, pump and cooler. "A" indicates the main oil supply to bearings; "B" the oil return pump; "C" the oil cooler, and "D" the Auxiliary oil pump.

LUBRICATION OF KNITTING FRAMES

Knitting machinery affords another example of where the use of lower viscosity lubricating oils will be a decided adjunct to increased and

more perfect production, as well as better power economies.

In the knitting mill such factors as power losses due to friction or incomplete coordination of motion, oil stained fabrics, replacement losses, the rate of production and the cost of repairs, enter markedly into the cost of production.

In order to reduce these losses, eliminate oil stains and repair expense as far as possible,

Courtesy of Textile Machine Works.

Fig. 5—View of a hosiery narrowing machine. The proximity of the various knitting mechanisms to the fabric requires the use and careful application of a very highly refined, light viscosity oil.

and keep production at a maximum the purest grades of lubricants of comparatively low viscosity should be used at all times. The reason for this is that knitting machine mechanisms are located in close proximity to the fabric, and any oil drips may damage the latter.

Warp Knitting Machines

Warp knitting machines of the Tricot, Milanese and Jacquard Raschel-types will require careful lubrication of the needle, guide, sinker and presser mechanisms. In general, the lubricant, which should be a high grade stainless knitting oil, must be carefully and sparingly applied to prevent access and possible damage to the fabric.

The cams and other operating mechanisms, including bearing boxes, should also be lubricated with the same oil, similar care being exercised in its application. Such other operating parts as frame bearings, motors, driving gears and chains are less apt to cause damage to the fabric through faulty lubrication; yet to insure economy and maximum production their lubricants must also be carefully selected and applied. For roll and motor bearings a straight mineral oil of from 180 seconds to 200 seconds viscosity is recommended. For gears and chains a relatively light grease will serve the purpose admirably.

In circular or tubular knitting machines a point where careless selection and application of the lubricant may cause trouble is on the roll take-ups and worm gear attachments which serve to keep the fabric under uniform tension during knitting. For this service a pure stainless knitting oil should always be used in order to eliminate excessive loads upon the needles as well as to prevent gumming.

Were the oil to gum and become relatively stiff the rollers would work sluggishly and abnormal wear would be apt to occur, not to mention the increase in power consumption. It is, therefore, advisable to watch such mechanisms carefully and even though the best grade of oil is used, to remove and rinse them in kerosine about once every month to insure that they are perfectly clean and free from gummed oil or accumulated dust and lint.

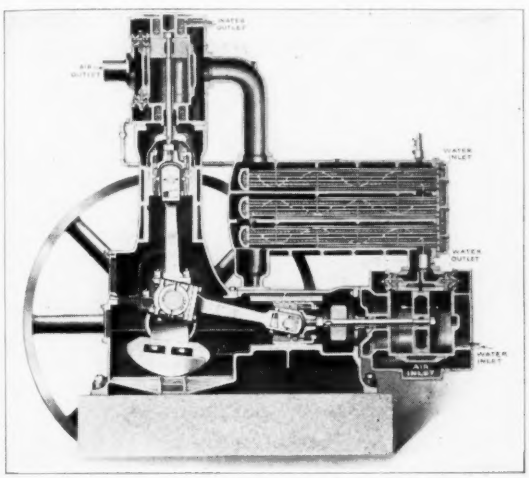
To prevent oil spots on the fabrics, needle cylinders and dials on certain of the circular knitting frames must also be oiled carefully. Self-feeding oil cups are sometimes installed on the machines for this purpose but owing to their positive action, unless promptly turned off whenever the machine is stopped they will tend to flood the working parts and cause serious oil spots or even streaks.

Application of Lubricants

Knitting machines may be lubricated either by the machine operators themselves or by a mechanic or fixer who has charge of entire plant lubrication. There are advantages and disadvantages pertinent to both methods, although the latter is perhaps the most satisfactory unless the operators are properly instructed as to the manner in which their machines should be lubricated. At all events, whoever has this duty to perform should fully understand the machines and their respective parts that require lubrication, and should appreciate the detrimental effects that careless, sloppy or excessive oiling may have upon the knitted fabric. Knitting machines should be lubricated at regular intervals, the frequency to be based on their actual time of operation.

Turbine Bearing Lubrication

Choice of the proper viscosity in steam turbine service is also of the utmost importance. Research for the purpose of improving lubrication has indicated that there are marked benefits to be derived from the use of lower viscosity lubricating oils wherever constructional and operating conditions will permit.



Courtesy of Sullivan Machinery Company.

Fig. 6—Sectional view of an angle compound air compressor. Controlled lubrication, frequently by use of comparatively low viscosity, straight mineral oils, is an important adjunct in the development of proper operation, with the formation of a minimum amount of carbon or other deposits.

Steam turbine lubrication must very frequently be maintained for an indefinite period of time, over which the oil is continuously recirculated through the bearings, and in reduction geared machines over the gear teeth, with only the protection afforded by partial by-passing of a certain amount for continuous or periodic filtration or centrifuging.

Circulation of oil in this manner imposes a severe duty, especially where moisture or high temperatures may prevail to any extent. As a result, the original degree of refinement of a turbine oil must be such as to make it highly resistant to oxidation, emulsification and sludge contamination. Provided the normal operating temperatures are not too high, as in the case of machines where the steam inlet may be close to one of the bearings, the lower the viscosity of the oil the more effectively will these requisites be met.

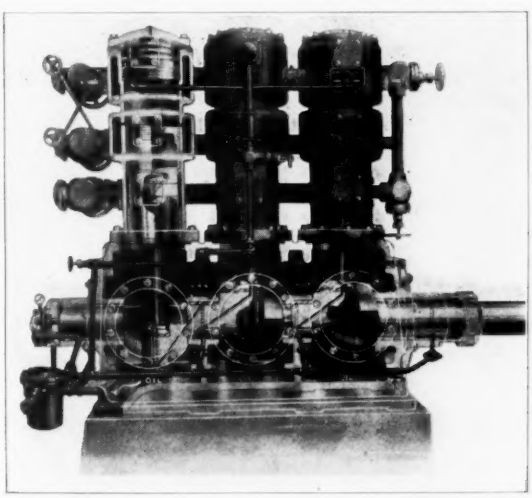
Relation of Viscosity to Demulsibility

There is a marked relationship between viscosity and demulsibility in view of the fact that this latter is most important in the maintenance of a steam turbine oil in suitable condition for performing its intended function. In consequence, a realization of the fact that lower viscosity oils are normally of a higher degree of demulsibility and have a more ready ability to separate from sludge formation or other non-lubricating matter is essential. Therefore, while steam turbine oils are normally selected with most careful regard as to their demulsibility it is safe to say that viscosity is of equal importance.

VISCOSITY A FACTOR IN HEAT TRANSFER

In connection with this matter of viscosity, it is important to remember that in steam turbine service a fairly high range of operating temperatures may prevail, i.e., from 130 to 175 degrees Fahr. Inasmuch as viscosity varies inversely with temperature the matter of adequate body within the lubricating film must always be borne in mind, even though flood lubrication is maintained and in many instances there is a certain amount of pressure.

Where this latter prevails, of course, the actual volume of oil which is continuously being passed through the bearing clearance spaces will, in part, make up for any possible failure of the oil film due to reduced viscosity.

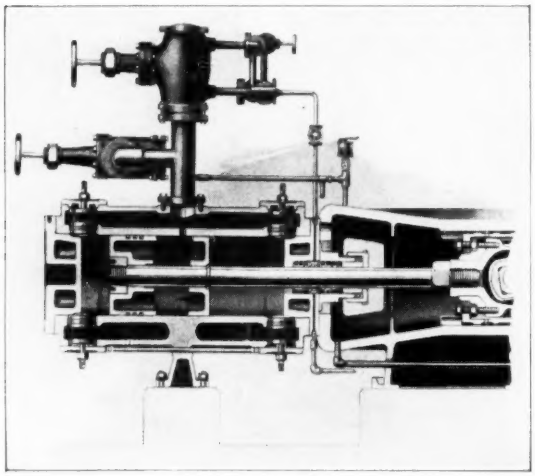


Courtesy of Howe Ice Machine Company

Fig. 7—Sectional view of a Howe multiple effect refrigerating compressor. Here again, dependable lubrication under sufficient pressure using a comparatively low viscosity oil, is essential. The oil is delivered by the pump directly to the center bearings from which it is distributed to all other bearing surfaces. Note, in particular, the oil piping from the gear pump to the various bearings, and path of return oil to the filter.

On the other hand, the extent to which a turbine oil may be subjected to high temperatures will depend upon the turbine itself and the rate at which the oil is being circulated. During operation, therefore, the oil may either receive heat from an external source, such as

the steam, or abnormal heat may be developed within the bearing, due to imperfections in the lubricating system causing unusual internal friction.



Courtesy of I. P. Morris and De La Vergne, Inc.

Fig. 8—Cut-away view of a De La Vergne horizontal compressor cylinder showing oil piping to gas intake, and stuffing box "oil lantern," also details of construction of this latter.

Heat as received from the steam may be either conducted or radiated. At the high pressure end of the machine, conduction will be more probable, for steam at temperatures in the neighborhood of 600 degrees Fahr., will certainly impart considerable of this heat to the adjacent bearings, frequently regardless of the provisions for cooling these latter. Transmission of heat by radiation to the bearings as well as to the oil piping, will also occur to a certain extent, although this will naturally depend upon the provisions for ventilation, and the operating temperature of the turbine room.

In connection with this matter of temperature, it is interesting to note that as a general rule room temperature variations which are oftentimes regarded as negligible factors are in reality of considerable importance. In fact, they will have a direct effect upon friction and the consequent temperature rise.

The generation of abnormal heat within a bearing, however, may be the result of an excess of internal friction, due to the oil being too heavy or viscous, the circulation being too rapid, or perhaps the oil ways or ducts being partly clogged by emulsified matter. It is difficult to determine offhand just what the cause for overheating may be unless there is but little opportunity for the bearing to receive heat from external sources. In this event faulty lubrication can in general be assumed as being the cause.

Cooling a Function of the Oil

Inasmuch as one of the chief functions of a turbine oil is to serve as a bearing coolant, it is perfectly evident that every precaution must be taken to keep the oil under circulation as cool as possible, otherwise, its viscosity, and hence its pressure-supporting ability will be excessively reduced, sometimes even to such an extent as to render the oil incapable of keeping the shaft from coming into actual metal-to-metal contact with the bearing.

This is most positively prevented by flooding the bearings with an excess of the right grade of oil under a certain definite pressure. While heat alone will lead but to the possibility of faulty lubrication from the viewpoint of lack of pressure-resisting ability, heat in company with water and air is the forerunner of oxidation, emulsification, and the subsequent formation of insoluble sludges. Therefore, every effort should be made to keep turbine bearing (and consequently oil) temperatures as low as possible. This is the primary reason for installing an oil cooler in connection with the lubricating system.

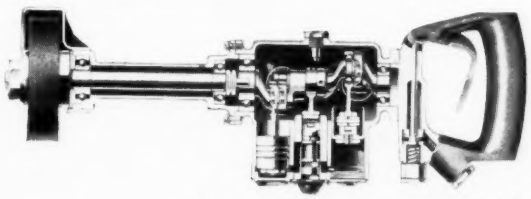
Present Day Viscosity Limits

No definite data has as yet been derived which can be safely said to actually aid the operator in selecting oils of the proper viscosity. It is more or less a problem based upon the operating conditions involved. As a rule, however, there should be little difficulty, inasmuch as turbine builders and oil refiners in company with the technical experts of a number of public utilities have cooperated to a sufficient extent to prove that an oil for pressure lubricated turbine bearings can be safely as low as 140 seconds Saybolt at 100 degrees Fahr., although ring oiled bearings may require a somewhat heavier oil. Whether subsequent research will develop that for certain types of bearings and turbine construction any lower viscosities can be recommended is but a conjecture at this time; based on the experience of the electric railway and the textile industry, however, it would seem to be a likely development.

Where reduction gears are involved, whenever the same oil is to be used for lubrication of both gears and bearings, a certain increase in viscosity may be necessary in order to insure effective lubrication of the gears. Here duty will be considerably heavier, imposing pressures on the lubricating film in excess of those involved in the bearings.

On the other hand, this lubricant must not be so heavy as to lead to the development of abnormal internal friction within itself when in service in the bearings. An oil with a steep viscosity curve has been found to be the most adaptable for such service; that is, it should

maintain its original viscosity as nearly as possible when in service in the gear case; yet be capable of decreasing so rapidly in viscosity with normal increases in temperature that when fed to the bearings at temperatures in the neighborhood of 140 degrees Fahr., it will be reduced to approximately the viscosity of the lighter oil which would normally be used for bearing lubrication alone.



Courtesy of The Cleveland Pneumatic Tool Co.

Fig. 9—It is essential to use extreme care in the lubrication of pneumatic tools. The above view shows a cross-section of a grinder, as used for light and medium service. Note the ball bearing arrangement of the driving motor and main shaft.

Reduction Gear Service

Wherever an oil is to be used for the lubrication of both reduction gears and bearings it should seldom have a viscosity below 300 seconds Saybolt at 100 degrees Fahr. In general, an oil of this viscosity will function with perfect satisfaction in the average stationary, reduction geared turbine. In marine service, on the other hand, the size of the gears may be considerably larger with corresponding increases in tooth pressures. Therefore, it will often be found advisable, in such cases, to use an oil of approximately 500 seconds Saybolt viscosity at 100 degrees Fahr., or even higher in abnormal cases.

An important point to remember, however, in the lubrication of reduction geared turbines, is that we should never use an oil of any higher viscosity than absolutely necessary, due to the fact that the heavier the oil, the less readily will it separate from water. Furthermore, unless bearing temperatures are above the average, there will be a tendency for marked increase in internal friction, due to the oil being too heavy for the service involved. This, of course, would lead to a certain increase in temperature, which would automatically tend to reduce the viscosity to a certain extent, with the result that ultimately an equilibrium temperature would be reached. We must, however, not overlook the fact that increase in temperatures will tend to increase the sludge formation.

Actually, therefore, the operator must watch his turbine temperatures carefully. If they tend to run above 140 degrees Fahr., unless there are certain mechanical conditions involved to which this can be directly attributed, he would be safe in investigating the suitability of his oil or the extent to which foreign matter and sludge are being removed.

In the Ceramic Industry

In the operation of brick and tile machinery there is a peculiar phase of lubrication, wherein the use of low viscosity petroleum products has proven to be a decided adjunct. This pertains to the dies of the auger machine, wherein the clay bar is compressed and forced through a die prior to being cut into bricks, the table of the clay cutting machine over which the clay bar must pass during the process of cutting, the repress brick machine, wherein the clay is given final compression and shaping prior to burning, and the tile press dies, which are used in the shaping of wall or floor tiles.

Table Lubrication

In the manufacture of bricks the essential purpose in lubricating the auger machine dies, as well as the clay cutting table, is to bring about as complete coordination as possible in the entire machine. Should there be any tendency for the clay to stick to the auger machine die, or to resist ready movement against the cutting machine table, there will be a tendency toward backing up in the machine, which might materially affect the production or even cause a shut-down in order to bring the clay back to its proper position in the machine.

In the repress brick machine, or dye press, however, the essential purpose is to prevent undue adhesion, in order that the raw products after being shaped may be removed without damage to the corners.

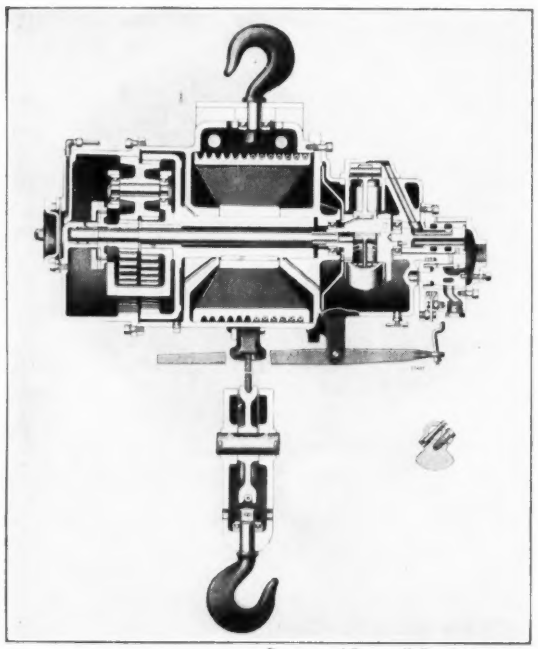
In order to insure constant feed against the continual pressure exerted by the clay in its passage through the auger machine die, to relieve the machine of abnormal back pressure or thrust, and aid in the formation of a smooth surfaced clay bar, the die must be suitably lubricated. Oil, water, or steam can be used for this purpose depending upon the construction of the die and the nature of the clay.

Where oil is used, a low viscosity straight mineral product is recommended by many authorities. Others, however, prefer to compound with a certain amount of fatty (animal) oil. These same products can also be used as table oils for the lubrication of the surface of the cutting machine over which the clay bar must slide. Unless this table is properly lubricated the bar may buckle, necessitating considerable loss of time and perhaps damage to the

machinery. All table oils are usually reduced with a varying proportion of kerosine according to the nature of the oil.

Clay Cutting Machines

On such machinery coordination of motion between the conveying apparatus and the cutter itself is of extreme importance. Cutting reel speed, in other words, must synchronize



Courtesy of Ingersoll-Rand Company.

Fig. 10—Sectional view of an air motor hoist, with the driving element located on the right. Both motor and gears are enclosed by their respective housings, which not only retain lubricant but exclude all dust and other non-lubricating matter. A comparatively light viscosity oil is used, especially for motor operation.

with the movement of the clay bar. Effective lubrication is one of the chief mediums by which this can be brought about in a properly designed machine.

A phase of lubrication occurs here wherein the friction between clay and metal must be considered, just as in the auger die. As the clay bar slides over the table of the machine it must not bind, else coordinated operation will be materially interfered with. To insure against this the table is oiled. In many plants the lubricant is referred to as a table oil, in others it is known as a press oil, for it must also be used in lubricating the dies and guides of repress brick machines. For this work both straight mineral oils and fixed oil compounds will be suitable, reduced with kerosine as necessary. Where the product slides over the lubricated surface such as on the cutting machine, straight mineral oils will function equally as well as compounded oils. Where pressing is involved, however, the latter must be used since mineral oils alone may give rise to adhesion of the clay and imperfect delivery of the bricks. The ratio of reduction may vary from 1 to 2, to 1 to 20, according to the work at hand. All die and table oils must also be selected with a view towards obviation of scum, or discoloration of the products when dried and fired.

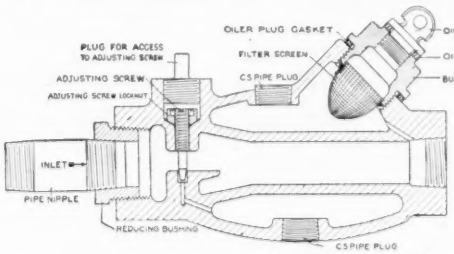
Repress Brick Machines

While repress machinery differs materially from any of the other equipment already discussed the essential wearing parts which require lubrication are akin. Therefore, the general grades of gear and bearing lubricants can be used as necessary. Press lubrication is also very much the same as table lubrication which has just been discussed above, though it has been found that straight mineral oils cannot always be relied upon.

The only feature of difference affecting the operation of wearing parts is the amount of pressure involved. In some cases this might render it advisable to lubricate bearings and cams with a somewhat heavier grade of lubricant of even perhaps 500 seconds Saybolt viscosity at 100 degrees Fahr. Oil is usually fed to the press forms from a storage chamber built into the machine itself.

Press Lubrication

The lubrication of tile press dies and clay has a marked influence on production. The purpose of lubricating these dies or mixing oil with the raw material is to prevent adhesion of the clay and to insure the delivery of the product in the proper shape with perfectly straight edges and square surfaces. Mineral oils in compounds with fixed oils have proved to be the most satisfactory lubricants for this service, the purpose of the latter being to counteract, by emulsification, the effect of the mois-



Courtesy of Ingersoll-Rand Company.

Fig. 11—Sectional view of an air line oiler, showing details of construction and essential parts. Note location of the oil plug and means for adjusting oil flow into the air line. Here again a comparatively light viscosity oil should be used.

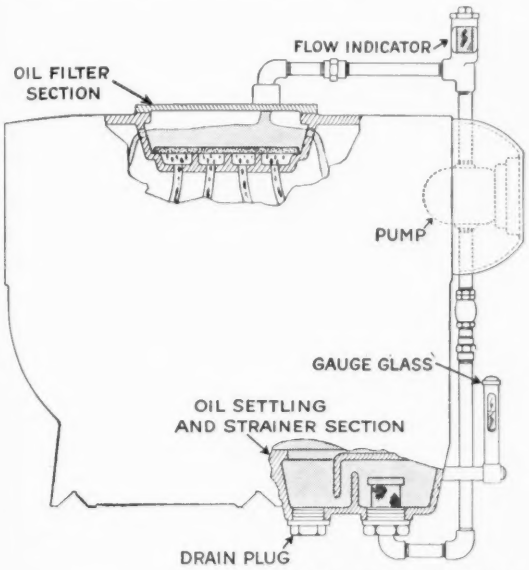
ture in the clay and to give a perfectly lubricated surface to the die.

It is customary to prepare press oils of this nature of varying concentration and viscosity by reducing the purchased product with a certain amount of kerosine. The nature of the

clay and the work at hand is usually the guiding factor in the determination of the proportion of kerosine to be added. Straight mineral products cannot be used as press oils due to the inferiority of the resultant lubricating film in the presence of water.

General Machine Inspection

In the attainment of reduction in cost of machinery upkeep and improvement in power economy through greater efficiency in operation, one of the most essential factors is regular inspection. Normally this can be divided into two classifications, according to the thoroughness with which it is carried out.



Courtesy of The American Tool Works Co.

Fig. 12—Details of a modern automatic oiling system on a lathe head. Here the oil is pumped by a Brown and Sharpe oil pump from a reservoir at the bottom, to a distributing chamber in the top cover as shown. Note that all oil is filtered through a felt pad prior to distribution to the bearings.

An inspection of all machinery should be made daily to note the general external condition and the operation of the lubricating equipment. At other periodic intervals, however, more complete inspections should be made. At this time machinery should be taken down in part, dust guards removed and wherever advisable the conditions of the bearings, gears or other moving parts studied with a view to determining faulty operation before it goes so far as to perhaps require replacement.

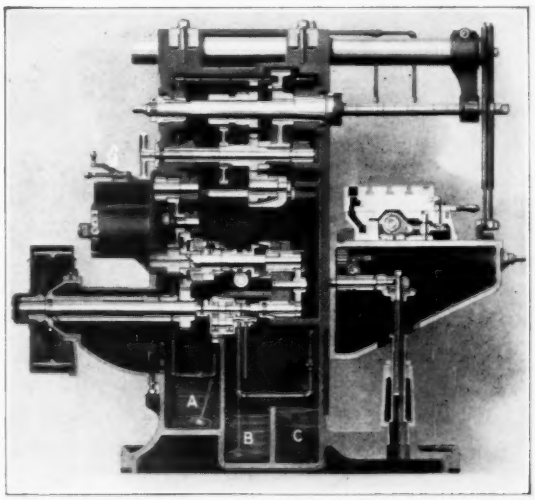
In the determination of the period for such an inspection complete cooperation with the operators and mechanics should prevail. Furthermore, one should consider the type of machinery and the function performed, the manner of lubrication, the extent to which continued operation must be carried out and the intelligence of the operators.

It has been decidedly in the interests of power economy to make such inspections with every care, for but a small amount of readjustment in many instances will preclude abnormal wear, increase in power consumption and other phases of inefficient operation which would lead to increase in the cost of operating the plant.

In the course of carrying out an inspection it will be advisable to consider the life of the machinery involved, the possibility of it becoming obsolete through improvements in manufacturing processes, as well as the manner in which operation is carried out.

If a machine is soon to become obsolete it would be better, after a certain amount of wear and tear, to consider replacing it with a new and up-to-date unit rather than to attempt to renew worn parts and make it serve for a longer period of time.

This might be economy in installation costs, but by virtue of the amount of power consumed and perhaps the reduced speed of operation as compared with more up-to-date equipment, it would react decidedly upon the cost of the finished goods.

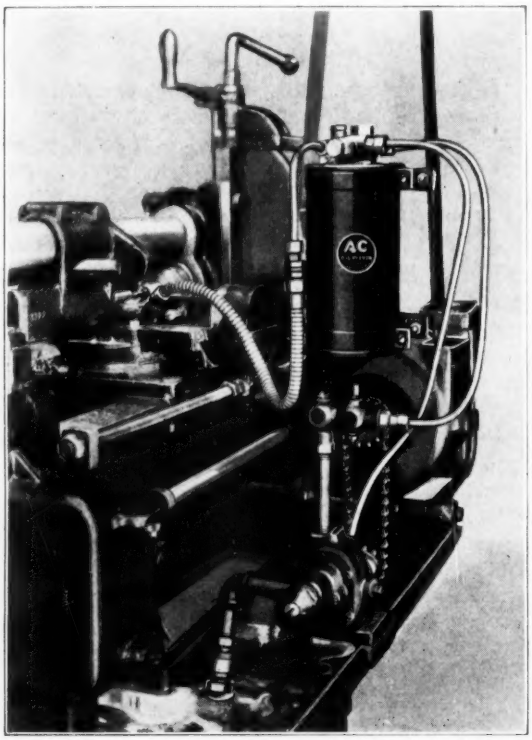


Courtesy of Kearney and Trecker Corp.

Fig. 13—Constructional details of a milling machine designed for automatic flood lubrication. The lubricant is stored in reservoir A, being pumped to the top of the machine for distribution to the wearing elements. Reservoirs B and C serve for storage and settling of cutting coolants and lubricants.

In the course of inspection of lubricating equipment it will be advisable, when necessary, to clean out same as thoroughly as possible,

wash out the bearings, fill oil reservoirs and lubricator tanks with fresh oil. It will also be advisable wherever there is a possibility of non-lubricating, abrasive foreign matter gaining entry, to remove bearing caps and engine cylinder heads to determine the extent to which lubrication is effectively preventing the wearing surfaces from being scored and worn by such material.



Courtesy of A. C. Spark Plug Co.

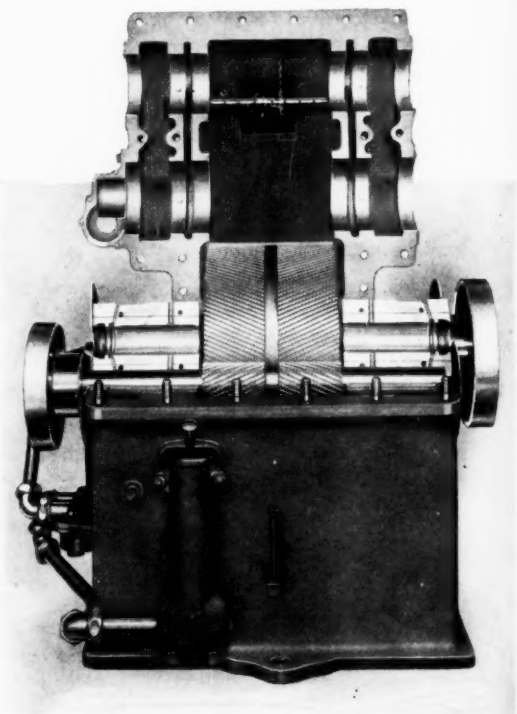
Fig. 14—In machine tool operation lubrication can be materially improved by maintaining oil in as clean a condition as possible. This will hold true where particularly light viscosity oils are to be used, and where there is a possibility of any extensive amount of abrasive non-lubricating matter gaining entry.

It may be safely said that inspections of this nature will improve the operating efficiency to a great extent and lengthen the useful life of the parts involved. Furthermore, this will enable one to judge the protective ability of the lubricant used and will be a guide as to whether a change should be made in the lubricating characteristics of the latter or the method of application, size of oil piping, arrangement of oil ducts or alteration in the rate of delivery of the lubricant.

Frequency of Cleaning

Whenever a so-called heavy inspection is planned for, arrangements should also be made for general cleaning. On machinery adapted to the use of lower viscosity oils, construction of the bearings and other parts involved will usually be such as to prevent abnormal entry of non-lubricating foreign matter. A certain amount of this will be bound to gain entry, however, regardless of the construction. Therefore, a general periodic cleaning will be excellent insurance against the development of abnormal wear.

In the steam turbine, the use of oil purification equipment will prevent this by the automatic removal of such foreign matter. On ceramic machinery, the textile spindle, and other types of more or less exposed and intricately constructed equipment, however, the only way to assure dependable lubrication is to maintain the oils in a suitable state of purity by normal cleaning and removal of accumulated dust, dirt or other foreign matter at regular intervals.



Courtesy of The Terry Steam Turbine Co.

Fig. 15—View of the Terry reduction gear, showing the oil retaining grooves to provide against oil throwing, and the extra large strainer located in the base. This is installed in the oil line to prevent lint, grit and dirt from reaching the lubricated surfaces. Note the absence of an excessive amount of piping.

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